ADVANCED VOTING SYSTEM AND METHOD

RELATED APPLICATION

This application claims the benefit under 35 U.S.C. § 119(e) of U.S. Provisional Application Serial No. 60/308,465 filed July 26, 2001 entitled "Advanced Voting System," Attorney's Docket No. 018106.0109.

TECHNICAL FIELD OF THE INVENTION

This invention relates generally to voting, and more particularly to an advanced voting system and method.

BACKGROUND OF THE INVENTION

Voting systems have a variety of underlying objectives. First, a cornerstone of any democracy is an accurate voting system that minimizes disenfranchisement of voters. However, count accuracy is difficult because the large number of voters who participate in an election create variances in ballot output. Another objective of voting systems is to accurately gauge voter intent. Despite this objective, many factors may lead to situations in which voters are unclear as to what is required of them or unclear in indicating their selections. Such factors include ballot design, cumulative voting, multiple positions available for one office, proximity of candidate names on a ballot, unintentional markings left on a ballot, and misspelling of write-in candidates. Additionally, in some elections eligibility requirements or the issues involved restrict who has the right to vote. Thus, voting systems must also attempt to ensure that voters only vote the legal number of times and in the proper jurisdiction.

Methods of voting and counting votes have been in use since the earliest of human times. A paper ballot is a simple voting tool that is usually preprinted with the names of the candidates for a given office. In a paper ballot voting system, the voter marks an 'x' next to each candidate's name for whom the voter cares to vote. To maintain privacy, the voter folds the ballot and hands it to an election judge who deposits it in a ballot box. Alternatively, the voter may be requested to place the ballot in the ballot box himself. A second voting system developed to further these objectives uses mechanical voting machines. Typically, mechanical voting machines have levers next to the names of candidates and counters that increment each time a voter moves a lever to vote on a specific candidate or question. In a third system, the voter is given a paper ballot, called a punchcard, that contains perforated or otherwise weakened areas. The punchcard is inserted into a machine that displays the names of candidates or the questions in a referendum. The alignment of the punchcard in the machine is such that when the voter inserts a stylus next to the candidate's name, a piece of paper is punched out. The paper that is removed is called a chad. The hole in the place where the chad once was can be detected by a light sensitive card reader to determine the vote. In yet another system, the voter is given a paper ballot and the voter is asked to fill in a circle or box associated with the candidate or other ballot question. As is other paper ballot systems, the ballot is placed in a ballot box and is

read at a later time. The machine that reads these ballots find light passing through some circles or boxes and not through others. The presence or absence of a mark in a box or circle indicates the voters' choices. Such systems are called "mark-sense" systems or, alternatively, optical scan systems.

Regardless of the system employed, problems have always existed with such systems. The first and foremost deficiency is count accuracy. When it comes to large numbers of ballots, human readers are often more prone to error. Mechanical voting machines improve the counting process by creating a tally for each candidate or question that can be recorded by election officials at the end of the election. Although more accurate, faster, and less labor intensive, mechanical voting machines do not leave an audit trail for authorities to follow in times of a recount. Additionally, voters have become disenfranchised by mechanical voting machines since allegations of tampering with the counters are difficult to dismiss and also because the voter has no assurance that his vote was tallied correctly.

Another deficiency in current voting systems stems from human error in making a selection. Variances in how voters mark a selection and erase a selection may render paper ballots unclear. Punch card systems attempt to replace human counting and selection entry errors with machine certainty, but create problems unique to punch cards. For example, voters may not force the stylus through with enough force to completely remove the chad. When entered into the counting machine, a partially removed chad may be reinserted into the hole nullifying the voter's intent altogether. Furthermore, a punched punchcard cannot be unpunched. An error in making the voter's selection requires the voter to begin the voting process anew.

Furthermore, other problems with a paper ballot voting system are overvoting and undervoting, which occur when a voter either votes for too many candidates or too few candidates, respectively. Mechanical voting machines sufficiently diminish this problem by making it difficult for a voter to vote for more candidates than is appropriate and by reminding the voter when a particular office or question has not been voted on. However, punch card and optical scan systems cannot detect an overvote or undervote until the votes are tallied. Additionally, where ballots are not

counted immediately at the polling place, the voter is never afforded the opportunity to correct the situation.

Thus, regardless of the system employed, whether it is conventional paper ballots, mechanical machines, or punchcards, each system has deficiencies that effect the accuracy and efficiency of the voting process. The presidential election of 2000 has increased public awareness and concern about current systems employed.

SUMMARY OF THE INVENTION

According to the present invention, disadvantages and problems associated with previous voting methods and systems have been substantially reduced or eliminated.

According to one embodiment of the present invention, an advanced voting system includes one or more data storage locations. The one or more data storage locations store a plurality of registration records. Each registration record includes identifying information associated with a voter. Advanced voting system also includes an election key generator that generates an election key storing information specific to each voter. Additionally, advanced voting system includes one or more computing devices. The one or more computing devices interface with the election key and retrieve information from the election key. The one or more computing devices also display ballot questions based on the information retrieved from the election key and receive interactive voter selections from the voter. A ballot generator generates machine-readable ballots encoded with the voters selections.

In another embodiment of the present invention, an absentee ballot includes a plurality of machine-readable barcodes. Each barcode is associated with a voter option. The absentee ballot also includes a voter selection area associated with each barcode. The voter selection area is positioned such that when a voter marks a selection in the voter selection area, the associated barcode is altered so as to indicate a voter selection of the associated voter option.

Particular embodiments of the present invention provide one or more technical advantages. For example, one or more embodiments of the present invention may increase the accuracy of both the voting process and the vote tallying process while maintaining an audit trail for the purpose of recounts and challenges. An audit trail allows for more accurate, fair and expeditious procedures during a recount. As another example, certain embodiments of the present invention may more accurately reflect the intent of the voter through the use of interactive feedback and the voter's ability to change votes before the vote becomes final. Additionally, machine readable ballots provided by particular embodiments may be read with greater accuracy than human readable ballots, and yet such embodiments of the present invention also maintain versatility for write-in ballots.

Another technical advantage provided by one or more embodiments of the present invention is improved efficiency of the voting process. For example, particular embodiments may provide tools used by election officials to prepare computer ballots and absentee ballots. Additionally, certain embodiments may provide an efficient scheme for counting and verifying ballots cast by absentee voters. As another example of improved efficiency, delays during the counting of ballots and while awaiting publication of election results may also be substantially reduced. Finally, one or more embodiments may also facilitate voting by voters who do not speak English or who may be visually impaired.

Furthermore, one or more embodiments of the present invention may provide some or all of the preceding technical advantages while maintaining the secrecy of the ballot and preventing fraud. In one embodiment, of the present invention, biometric identification may be gathered at the time the voter registers and then used to verify the identity of the voter at election time. Fraud may be further minimized by increasing the difficulty for imposters to vote in lieu of *bona fide* voters. As another example, certain embodiments may also protect the privacy of the voter by informing the voter of undervote and overvote situations in the privacy of the voting booth. Meanwhile, detection and treatment of undervotes and overvotes may be tailored to follow the election rules of a particular jurisdiction.

Other technical advantages may be readily apparent to those skilled in the art from the figures, description and claims included herein.

BRIEF DESCRIPTION OF THE DRAWINGS

To provide a more complete understanding of the present invention and the features and advantages thereof, reference is made to the following description taken in conjunction with the accompanying drawings, in which:

FIGURE 1 illustrates an example advanced voting system;

FIGURE 2 illustrates an example registration record for use with an advanced voting system;

FIGURES 3A and 3B illustrate example computer ballots and computer screen instructions for indicating a selection using an advanced voting system;

FIGURE 4 illustrates a voting record that may be generated by an advanced voting system;

FIGURE 5 illustrates an example method of using an advanced voting system; and

FIGURE 6 illustrates an example system for absentee voting.

DETAILED DESCRIPTION OF EXAMPLE EMBODIMENTS

FIGURE 1 illustrates an example advanced voting system 10 including one or more computing devices 12 that create an accurate, anonymous, and verifiable record of voters' selections in machine-readable form. Advanced voting system 10 includes a voter identifier system 14 that stores identifying information associated with a voter and verifies the identity of the particular voter at the time of voter check-in at the polling place. Additionally, advanced voting system 10 includes a voting booth 24 that is operable to display ballot questions, receive voting selections from a voter, and generate a ballot encoded with such selections. Furthermore, system 10 includes a tallying system 40 that is capable of decoding an encoded ballot or may communicate directly with the voting booth 24 to tally votes stored within voting booth 24.

Voter identifier system 14 includes a computing device 12, one or more data storage locations 16, and an election key generator 18. A previously created voter signature may be stored as a registration record 17. Registration records 17 are stored in a data storage location 16 that is operable to communicate with computing device 12 or that is included within computing device 12. Registration records 17, used to authenticate the voter's right to vote in the particular election, are described in greater detail below with respect to FIGURE 2. For example, an election judge may ask the voter to present a registration card and the signature on the card may be compared against the previously provided signature through the voter identifier system 14.

In one embodiment of voting system 10, identification of the voter through a registration record 17 allows an election key generator 18 to prepare an election key 20. Once a voter's identity has been verified using registration record 17, an election key 20 may be generated to enable the voter to vote in a voting booth associated with voter identifier system 14. Election key generator 18 is operable to communicate with one or more data storage locations 16 and computing device 12 to facilitate generation of the election key 20. The election key 20 may be encoded with a digital signature 22 of a specific election judge. A digital signature is an electronic signature that can be used to authenticate the identity of the sender of a message or the signer of the document. A digital signature is used to ensure that the original content of the message or document that has been sent is unchanged. Digital signature 22 may be specific to the particular precinct at which the voter is authorized to vote and may be

stored in data storage location 16. Election key 20 may be a bar coded card, a magnetic stripe card, an optical disc (such as a CD-RW or CD-ROM), a magnetic disc (such as a floppy disk), or any other suitable data storage medium operable to be encoded with digital signature 22 and/or any other appropriate information allowing a voter to vote at a voting booth 24. The digital signature 22 encoded on election key 20 may be decoded by the computing device 12 on which the voter makes his voting selections to ensure that the voter does not substitute a different ballot from the one the voter is authorized to use. Validation through digital signature 22 also prevents interested parties from procuring copies of a ballot and "hiring" citizens to go into the polling place and deposit a ballot completed by someone other than the voter. Digital signature 22 may also be used when the ballot is read, as is described below. Additionally or alternatively, voting booth 24 may use election key 20 to select the appropriate computer ballot containing the races and questions for which the voter is authorized to vote. In such embodiment, election key 20 may be used to unlock electronic ballot information previously stored at voting booth 24. In another embodiment, an electronic ballot may be stored on election key 20 itself. This particular election key 20 may be encrypted using public/private key or any other appropriate encryption technology.

As with a traditional voting system, the voter may be directed to a voting booth that allows privacy for the voter. As described above, system 10 includes one or more electronic voting booths 24 in which a voter may vote (using election key 20, if appropriate). Each voting booth 24 may include an associated computing device 12. In certain embodiments, computing device 12 may be a personal computer which might include such components as a mouse 26, headphones 28, keypad 32, and display screen 34. However, any other computing device, such as a handheld computer with an appropriate input device, may also be used. In an embodiment where a programmable handheld device, such as a personal digital assistant (PDA) is used, the programmable device itself, along with its memory may be used to display the ballot, record one or more votes, and communicate the votes to tallying system 40. In such a case, the memory of the handheld device is read and the handheld device is returned to election booth 24 to allow voting by a different voter.

To initiate the use of voting booth 24, the voter may insert election key 20 into computing device 12 or a peripheral associated with computing device 12 and may press an appropriate button on a keypad 32 or on a touch sensitive screen 34 connected to computing device 12 or otherwise indicate that the voter is ready to begin. In one embodiment, an election authority may ask the voter to insert into computing device 12 a specially coded compact disc (CD) which serves as election key 20. Insertion notification, a feature of some operating systems and CD readers may then be used to start the voting process. As previously described, computing device 12 may use digital signature 22 to verify that election key 20 is valid. Computing device 12 may then present a screen asking whether the voter would like help screens to assist with the voting process. The voter may choose to proceed through help screens or begin voting immediately without such help screens. Where computing device 12 includes a set of headphones 28, the voter may listen to prerecorded instructions that may have been stored as .wav files or any other appropriate audio files. The ability to provide instructions in an audio format facilitates the voting process for the visually impaired or by others who may not readily understand written text appearing on a computer screen 34. In a particular embodiment, instructions for using the computing device 12 may have information stored in several languages to accommodate voters for whom English may not be easy to understand. The choice of the language can be encoded in the election key 20 or may be selected by the voter. The use of such speech files may also be used to provide remote voting over the telephone. A voter may call into a specified number, be verified using a voice print analysis or any other appropriate technique, and then vote by speaking or pressing a number on keyboard 32 in response to the voice messages.

Computing device 12 may proceed to the computer ballot after the voter has received the instructions or has chosen to forego instructions. As an example, the first computer ballot question presented may be for the election of one or more candidates or for a referendum question. Any appropriate ballot formats may be used and presented to the voter. Furthermore, the voter may select a choice on a ballot using keypad 32, mouse 26, touch screen 34, or any other suitable technique. An example computer ballot and the process of indicating a selection on the ballot are described in

greater detail below with respect to FIGURE 3. Once voter has finished voting for a given ballot question by indicating his selections and by indicating his readiness to proceed to the next question, computing device 12 may determine if an overvote or an undervote has occurred. Alternatively and additionally, computing device 12 may determine all overvotes and undervotes after the voter has voted on all questions. Determining an overvote or undervote in an election in which only one choice is allowed (as for president of the United States) is very simple, as only one selection may be made. However, certain elections may ask the user to select *n* candidates from a list of *m* (as for a town council). An overvote occurs when voter selects more than *n* number of candidates. Conversely, an undervote occurs when voter selects fewer than *n* number of candidates. Computing device 12 will detect an overvote condition and proceed according to the rules of the election authority. Such rules could be the allowance of the overvote at voting time but disallowance of the vote at counting time, or not allowing the voter to overvote at all. On the other hand, if an undervote is detected, the voter may be warned that it has occurred and given a choice to proceed without adding another choice or to vote for another candidate.

When the voter has finished voting (which the voter may indicate or which computing device 12 may determine), the voter is presented with a summary on screen 34 showing the voter's selections. The voter may be presented with the choice of printing a completed ballot or returning to voting. When the voter indicates that all choices are final, computing device 12 generates an encoded ballot 36 using ballot generator 30 included in voting booth 24 or otherwise in communication with computing device 12. In one particular embodiment, the encoded ballot 36 includes a barcode encoded with the voter's choices. However, those skilled in the art will realize that generating a ballot 34 may include generating a magnetic card, punching a punch card, or producing any other machine-readable medium. In another embodiment, encoded ballot 36 may also contain a human-readable indicator of the voter's selections (that may also later be read by a document reader employing Optical Character Recognition (OCR) technology). The election authority may decide which type of ballot should be printed by computing device 12.

In addition to or instead of generating ballot 36, computing device 12 may store a voting record 38 of the voter's choices in a data storage location 16. Voting

record 38 may be used by the election authority as the official result of the election for that computing device 12 or the election authority may choose the encoded ballot 36 to be the official result. Where the voting record 38 is chosen to be the official result of the election, computing device 12 may communicate directly with a tallying computer 42 which will tally the votes as contained in voting records 38 of one or more computing devices 12. Alternatively, the computing device 12 upon which voter selections are entered may tally the votes directly and report results for that computing device 12. In either case, encoded ballots 36 may be used to verify the result of tallying system 40 in the case of a recount or audit. As such there should be a correlation between the voting records 38 in the memory of computing device 12 and the machine-readable encodings on an associated ballot 36. This correlation may be examined by election or judicial authorities should there be a recount or challenge after the election. By combining electronically tallying voting records 38 and generating encoded ballots 36, a technical advantage may be provided since advanced voting system 10 may offer election authority multiple checks on election results.

Voting record 38 may also contain a unique identifier linking voting record 38 to a particular computing device 12. Voting record 38 is described in greater detail below with respect to FIGURE 4. The unique identifier may also be added to the encoded ballot 36. The identifier may be used as a fraud detection device since it would be difficult for counterfeit ballots to contain a code identifying a computing device 12. Additionally, the memory of computing device 12 and the encoded ballot 36 may also be encoded with the digital signature 22 of an election judge. Digital signature 22 may be used as a method of authenticating encoded ballot 36. Using public key technology, ballots 36 so marked have a much smaller chance of being substituted with fraudulent ballots. Encoded ballot 36 may also include a ballot sequence number as another anti-fraud measure; however, to protect the secret ballot system, such ballot sequence number may be formulated so as to not reveal the identity of the individual voter.

In certain embodiments of system 10, voting booth 24 may also include a ballot reader 37 capable of reading encoded ballot 36 in the form generated by ballot generator 30. Alternatively, the reader 37 may be shared in a separate private location within the polling place. Voters may use the reader 37 to verify that the encodings on

ballot 36 actually express the voter's intent. If after receiving a translation of encoded ballot 36 from ballot reader 37, the voter desires to change encoded ballot 36, the voter may ask an election judge for a new election key 20 and the previously generated encoded ballot 36 may be destroyed. This ensures that in the case where encoded ballot 36 is the official vote, there is no opportunity for the voter who changes his mind to vote more than once.

The next step in the voting process is a formal tallying of the all cast votes using tallying system 40. In one embodiment, tallying system 40 may be at the polling place. The voter may present encoded ballot 36 to an election judge who then inserts encoded ballot 36 into a vote tallying reader 39. Vote tallying reader 39 is preferably capable of reading barcodes and other machine-readable formats, and may be connected to a tallying computer 42. Additionally, vote tallying reader 39 may be adapted to accomodate reading a large number of ballots 36. The tallying computing device 42 verifies that digital signature 22 of the election judge is correct and also verifies that the ballot sequence number on encoded ballot 36 has not been used before. This ensures that votes may not be counted twice as a result of confusion at the polling place. The tallying computing device 42 may also check that the computing device identifier, when added to encoded ballot 36, is valid.

When polling place tallying is used, tallying computer 42 maintains an ongoing and updated count for votes cast at that particular precinct. If tallying computer 42 loses its memory or must be reset for some reason, encoded ballots 36 can be reread by vote tallying reader 39 to recreate the precinct totals. After the last vote is cast, tallying computer 42 may be used to create a special printed report of precinct totals and may also contain digital signature 22 of an election judge. In one embodiment the report may be called in to a central counting facility, sent by fax or other electronic means, or manually carried to the central counting facility. The special report may also be machine readable. Thus, the central counting facility need only read, or otherwise tally the special reports of multiple precincts in order to obtain an authority wide result. In another embodiment centralized tallying may be used. In this embodiment tallying computer 42 and vote tallying reader 39 are located at a centralized location rather than at each precinct. As a further alternative, the tallying system 40 may not be necessary at all except for auditing votes in case of a recount or

election challenge. In such a embodiment, the vote may be tallied electronically using the voting record 38, as described above.

The various components of system 10 may be associated with one or more computers 12 in one or more locations. Fore example, some or all of voter identifier system 14, voting booth 24, and tallying system 40 may be located in the same location and be implemented using one or more computing device 12. Furthermore, voter identifier system 14, voting booth 24, and tallying system 40 may share one or more components, if appropriate. Additionally, although data storage device 16 for storing digital signature 22 is illustrated in FIGURE 1 as a separate storage location from data storage location 16 for storing registration record 17, it is recognized that all data could be stored in a single data storage location. Similarly, although shown as separate from computing device 12, it is recognized that data storage locations 16 may be included in computing device 12. For example, the hard drive of computing device 12 may serve as a data storage location 16.

A paper ballot voting system, as described above, requires printing specialized ballots prior to each election. In addition to being expensive, a pre-printed paper ballot system requires a sufficient amount of lead time for preparing and printing the ballots. Because system 10 requires no preprinted ballots, system 10 may be leased to an election authority to mitigate election costs. In one embodiment, system 10 could be leased to an election authority for the same cost of preparing preprinted ballots for a printed ballot system.

FIGURE 2 illustrates an example registration record 17 for use with advanced voting system 10. Voter registration is also an important part of any voting system 10. In previous systems, a voter registers to vote at an established registration facility or is registered by registrars at *ad hoc* registration facilities. When the voter registers, the voter typically signs his name. On an election day, when a voter presents himself at a polling place, he identifies himself and his identity may be checked by comparing a signature made at the polling place with the signature made at the time of registration. Previous systems depend on the skill of an election judge to verify that the signature made at the polling place matches the signature made when the voter registered. Election judge's are often not adequately trained in handwriting analysis and an imposter may be able to vote in lieu of the legally registered voter.

According to one embodiment of system 10, a voter registers to vote as described above and provides identification information such as a driver's license indicating the voter's name and address. Pertinent information pertaining to the voter is stored in a registration record 17, as described above with regard to FIGURE 1. Registration record 17 may include a number of fields or segments that each include information or other data relating to the voting process. This information or other data may be in alphanumeric, graphical or any other appropriate format. Contained in the fields within registration record 17 may be the voter's name 50, the voter's street address 52, the voter's city of residence 54, and the voter's state of residence 56 and postal code 58. The address fields 52-58 are often important to the registration process because the address fields may be used to determine the voter's precinct 60, which may also be stored in voting record 38. The address fields 52-58 and/or precinct 60 may also be used to determine the specific ballot questions to be issued to a voter in an election where local issues vary from place to place. The voter may also be required to sign a voter registration card. The signature provided may be used to verify that the person presented is the *bona fide* registered voter. In one embodiment, an election authority may choose to store an image of voters signature in signature field 62 of registration record 17.

In another embodiment, the voter may be required to provide a biometric sample in addition to or in lieu of the signature 62. A biometric sample may be associated with a high degree of certainty to certain personal, biological characteristics of a person and may be stored for later authentication purposes. The digital representation of a biometric sample may be stored in the biometric field 64. According to the biometric method selected by the election authority, more than one biometric sample may be stored and additional fields 68 for additional biometric samples may be reserved in registration record 17. The analysis of the biometric sample 64 and the linkage of that biometric sample 64 to a voter is called a biometric identification. That biometric identification may be a based on a thumbprint such as disclosed in U.S. Patent No. 5,729,334, a retinal scan as disclosed in U.S. Patent No. 5,956,122, a voice print such as disclosed in U.S. Patent Nos. 5,901,203 or 6,205,204, or any other biometric identification or combinations thereof. In order to account for changes in physical characteristics of registrants over time, the dates that each

biometric sample was created may be stored in date fields 66 and 70 of registration record 17. As shown in FIGURE 1, the biometric identification is stored in data storage location 16. In other embodiments, the election authority may opt to store the biometric identification in a centralized storage database or print the biometric identification on a portable medium such as a magnetic stripe card, bar coded card or other suitable medium.

Registration record 17 is used to authenticate the voter's identity at election time. In one embodiment, when the voter arrives at the polling place, the voter is asked to present a signature and that signature is compared against digitized signature 62. Election judge may also or alternatively ask the voter to present a polling place biometric sample of the same type that was provided when the voter registered and as is currently stored in field 64 or 68 of registration record 17. Polling place biometric sample can be used, in conjunction with appropriate computing facilities, to match the polling place biometric sample with biometric sample 66 stored in the registration record 17. The election authority may opt to store the biometric identification in a centralized storage database or print the biometric identification on a portable medium such as a magnetic strip car, bar coded card, or other suitable medium. One advantage of storing registration record 17 in a portable medium that is retained by the voter is avoiding centralized storage of biometric identification data, which may be seen by some as a threat to privacy. Nonetheless, the election authority may prefer a centralized storage to ensure that voters are not denied the right to vote simply because the voter lost his voter registration card or other medium storing the biometric sample. In such an embodiment, the polling place biometric sample provided by the user may be compared via communication techniques with the biometric sample 66 stored centrally or the centrally stored information may be copied or communicated to computing facilities at the polling place.

FIGURES 3A and 3B illustrate particular embodiments of example computer ballots 78 and computer screen instructions that may be used in conjunction with system 10. If the ballot question is for an office, as illustrated in FIGURES 3A and 3B, the voter is shown a screen that states the name of the office 80 and displays the names 82 and party affiliations of all candidates. Certain races, such as that for the President of the United States, may have coupled candidates such as president and

vice president. The candidate names 82 and other information identifying the candidates are each displayed along with a check box 84. Near to, and associated with the name of the candidate, may also be a candidate number 86.

Figure 3A illustrates a computer ballot 78 prior to the voter's selection of a candidate. In one embodiment, the voter expresses a choice by using mouse 26 or other appropriate input device to click on or otherwise make a selection of the candidate name 82, the box 84 next to candidate name 82, or the candidate number 86. Those skilled in the art will understand that a touch sensitive screen 34 may also or alternatively be used and the voter may touch the candidate's name 82, box 84 or number 86 to express a choice. Particular embodiments of the present invention also provide alternative methods for the voter to express a choice. As an example only, the voter may type the name 82 or number 86 of the candidate and, in so doing, the choice may be indicated in the box 84 next to the candidate name 82, as illustrated in FIGURE 3B. Election authorities may choose to have one, a combination of more than one, or all of these selection methods available to voter. Alternatively or additionally, the voter may also be able to indicate the desire to vote for all candidates with a particular party affiliation in a number of different races. Where desirable, voting system 10 may also support cumulative voting in one or more races.

A computerized voting system 10 may be new to many voters who are not experienced in using computers. Therefore, in one embodiment, the voting authority may decide to present only one question at a time on screen 34. Also, context sensitive instructions may appear on screen 34 after each voter action. According to one embodiment, when a ballot question 78 first appears, instructions 90 may be displayed on the screen regarding how to select a candidate and instructions 92 may be displayed regarding how to proceed to the next or previous questions. Instructions to the voter may be placed in a part of the screen that is not related to voting. To further minimize voter confusion, instructions to the voter may be displayed in a different typeface, color and/or font size. Additionally, an election authority may decide to include instructions 94 informing the voter that spoken instructions are available on a headset 28 if the voter clicks on instructions 94. As is illustrated in FIGURE 3B, after the voter indicates a selection, the context sensitive, on-screen

instructions 96 may be displayed to inform the user how to change his selection. The voter may then proceed with the next question or may return to a previous question.

Particular embodiments also provide the ability to guide the voter through casting a write-in ballot. Some election jurisdictions do not count write-in votes unless a candidate has properly registered as a write-in candidate. In that case, the voting system 10 may show a box on the screen indicating that write-in votes may be made when a voter has a write-in choice. The voter may be allowed to select "write-in" as a candidate choice using any of the above described methods. Once selected, an instruction may appear explaining that the voter will be able to write the name of the write-in candidate on encoded ballot 36 once produced by ballot generator 30. A space may be created on encoded ballot 36 allowing the voter to add such a name. The fact that there is a write-in candidate on the computer ballot is encoded in ballot 36 to allow for manual processing of the write-in. Alternatively, the voter may be instructed that he should type the name of the write-in candidate on keyboard 26 or otherwise enter the candidate's name. The voter may also or alternatively write-in the name manually.

As mentioned above, particular embodiments of the present invention allow the visually impaired or those who are not proficient in reading to vote. If the voter selects to listen to instructions on headphones 28 as described above, the voter is guided through the voting process by prerecorded spoken instruction. The name of the office and the candidates names are spoken to let the voter know who all the candidates are. The list may be repeated to minimize confusion. The voter may then be told to press a mouse button 26, press anywhere on the touch sensitive screen 34, or take any other appropriate action to indicate the selection of a candidate whose name is spoken at that time. To ensure the user's selection was properly registered, the system may then repeat to voter the selection that was made. Similarly, computing device 12 may speak instructions to voter on how to proceed (for example, "click now to go back" or "click now to go forward"). The voter's intent is registered by the time proximity between the spoken prompt and voter's pressing of the button or other appropriate action.

In one embodiment, the election authority may decide at the time the user leaves each ballot question to perform an undervote/overvote test, as described with

regard to FIGURE 1. Again, depending on a particular embodiment and election laws, overvotes and undervotes may or may not be allowed. According to the options provided by particular embodiments, the user may be warned that an undervote or an overvote has occurred at the time the voter leaves a ballot question. Alternatively or additionally, such warnings may be presented to the voter at the end of the voting session, according to the rules of the election authority.

FIGURE 4 illustrates a voting record 38 that may be generated by system 10. As described with regard to FIGURE 1, system 10 maintains a voting record 38 of each vote on each question as selected by the voter. Voting record 38 may contain the ballot sequence number 102 described above, the ballot page 104 for which the voter made a selection, and each choice 106 made by voter. For an election, such as for president, where only one vote may be cast, only one choice 106 will have been recorded in voter register 38. By contrast, elections for offices electing more than one candidates to a position, such as town council, several choices 106 will be recorded in voting record 38. An example embodiment of the present invention allows up to 32 choices per ballot page 104. Furthermore, an apparatus identifier 110 may identify a particular computing device 12 used by the voter to prevent fraud. The date 112 of the election may also be stored in voting record 38 as a further check. In an effort to protect the identity of the voter, election authority may choose to record only the date, and not the time, of the registration of a choice 106. A different record 38 may be stored for each different ballot question. For a given voter, the ballot sequence number 102 is the same in each such record 38. This allows each voter to review on his or her choices and protects choices made by other voters from being accessed.

FIGURE 5 illustrates an example of a method for using advanced voting system 10. The method begins at step 150 by storing identifying information for a particular voter in registration record 17. As described in regard to FIGURE 2, registration record 17 may contain the voter's name, address, precinct, and a digitized signature. Additionally or alternatively, voter may be required to submit one or more biometric samples, which may also be stored in registration record 17. When voter arrives at the polling place; a voter's identity may be authenticated at step 152 by comparing a presented signature or other identifying information with the digitized signature 62 or other identifying information stored in registration record 17. In

embodiments utilizing biometric samples, a biometric sample 64 stored on registration record 17 may be compared to a biometric sample submitted at the polling place (instead of or in addition to the signatures being compared).

After voter's identity is authenticated, an election key 20 is generated at step 154 and given to the voter. An encoded digital signature 22 of the election judge for voter's precinct may be stored on election key 20. The voter inserts election key 20 into computing device 12 associated with a voting booth 24 (or a peripheral in communication with computing device 12) at step 156. Computing device 12 may communicate with election key 20 at step 158 to retrieve voter information. For example, voter information may include an electronic ballot to be used by the voter that was stored on election key 20 or information identifying an electronic ballot stored at computing device 12 to be used by the voter.

At step 160 after an appropriate ballot or other voter information is retrieved, computing device 12 presents an instruction screen to the voter to allow the voter to decide whether to see detailed instructions before voting. In one embodiment, step 160 may also include the voter choosing to listen to auditory instructions and donning headphones 28 connected to computing device 12. Alternatively, voter may choose at step 160 to forgo the instruction screens altogether. At step 162, the first ballot question 78 is presented to the voter. Example ballot questions 78 were described in greater detail above in regard to FIGURE 3. Voter then enters voter selections to the ballot question at step 164. In one embodiment, step 164 includes the voter indicating a selection by typing on keyboard 32. In other embodiments, step 164 may include voter indicating a selection by clicking on mouse 26 or touching touch-sensitive monitor 34. As part of step 164 and after voter has indicated his voter selection, a screen may appear that informs the voter of how he may proceed to the next ballot question or return to the previous ballot question. Computing device 12 may audit voter's selection as a step 166 to determine whether there has been an undervote or overvote before proceeding to the next ballot question. Where such an irregularity is detected, computing device 12 may inform voter of the situation and may prompt voter to remedy the situation if local election laws allow. Alternatively this step may not be performed at all or may be performed after the voter has completed the ballot.

At step 168, computing device 12 determines whether there are additional ballot questions to be presented to the voter. If additional questions exist to present to the voter, the method returns to step 162 and computing device 12 presents the next question to the voter. Computing device 12 will continue the process by proceeding through steps 162-168 until the last ballot question 78 is presented to the voter. After all ballot questions are presented to the voter, the method proceeds to step 170 where computing device 12 presents the voter with a summary of voter selections. In one embodiment, step 170 includes giving the voter the choice of either finalizing voting selections as they appear in the summary or returning to previous screens to change his voting selections before finalizing his voter selections. Where voter chooses to return to previous screens, the method will return to step 162 and proceed forward from there. At step 172 the voter's selections are stored in an anonymous voting record 38. Multiple voting records 38 may be used for audit purpose when irregularities are discovered or when a vote is challenged.

As described above, computing device 12 may be coupled to ballot generator 30. Step 174 includes production of a machine-readable encoded ballot 36 by ballot generator 30. Encoded ballot 36 may be encoded with the voter's selections. At step 176, voter selections are tallied. In one embodiment, the multiple encoded ballots may be tallied by a tallying computing device 42. Step 176 may include feeding the encoded ballots 36 to a ballot reader 37 that tallies the votes at each precinct. Alternatively or additionally, step 176 may include tallying encoded ballots 36 at a centralized location. In such embodiment, encoded ballots 36 may be carried to the centralized location or may be electronically transmitted to the centralized polling place. As a further alternative, step 176 may include tallying the multiple anonymous voting records 38 generated by computing device 12 to produce precinct totals.

At step 178, a determination is made as to whether any irregularities have occurred in either the tallying process or the selections cast. This determination may be made by a computing device, the tallying computer, a ballot reader, or a person associated with the election authority. If such a problem has occurred, the method may continue by recounting encoded ballots at step 180. Additionally or alternatively, voting records 38 as stored in computing device 12 may be recounted to provide an additional check on ballot totals. Recounts may also be made using a

substantially similar procedure as described in above with regard to step 178 in response to requests by candidates or others challenging election results.

Computing device 12 may proceed through the voting process in the order as shown in steps 150-180 in FIGURE 5 and as described above. However, it is recognized that one skilled in the art may perform the steps of the method in any suitable order.

FIGURE 6 illustrates an example system for absentee voting. Absentee ballots 118 can play an important role in an election. It is difficult to ask voters to prepare a bar coded ballot expressing the voter's intent. Bar codes are usually prepared by a machine and such machines are not likely to be available to an absentee ballot voter. Some prior art systems attempted to solve this problem by supplying the absentee voter with pre-printed bar coded stickers containing encoding pertaining to all candidates. In addition to being expensive, adhesive labels may be destroyed prior to reaching the user or adhesive labels may become subsequently stuck in a reading machine.

One embodiment of the present invention allows absentee ballots 118 to be distributed to voters without such adhesive backing. As shown in FIGURE 6, associated with each candidate is a bar code 120 that contains an encrypted code that will define the voter's choice. The ballot also contains an identifying area 122 with the name, picture, and/or other information identifying the candidate. Near the start of the bar code is a box 124 and two arrows 126 straddling bar code 124. When indicating a choice, the absentee ballot voter is asked to fill in box 124 between the pair of arrows 126 with a pen or pencil. When box 124 is filled in, the appropriate bar code will be obliterated. For an example to demonstrate this technique, assume that bar code 124 for candidate George Washington contains the code "2." Assume that the bar code 124 for candidate John Adams contains the code "1." When the voter fills in box 124 in order to vote for George Washington, the code "2" will no longer be able to be read by the machine reader. When read, the absence of the code associated with the candidate along with the codes (not obliterated of the other candidates for the same office) unequivocally indicates the voter's choice in a machine readable fashion. Possible technical advantages of such a system are

improved accuracy and rate of speed in counting absentee ballots 118. A tallying system 40 may be used to count such absentee ballots 118.

Although the present invention has been described with several embodiments, numerous changes, substitutions, variations, alterations, transformations, and modifications may be suggested to one skilled in the art, and it is intended that the present invention encompass all such changes, substitutions, variations, alterations, transformations, and modifications as fall within the spirit and scope of the appended claims.